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# REMOTE SENSING ALUMNI IN THE FACULTY OF GEOGRAPHY GADJAH MADA UNIVERSITY

**It's temporal distribution in relation to the progress of the internal and external factors**

by
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## ABSTRACT

*Remote sensing is a very useful tool for geographic study. It is on the basis of this idea that this subject has been offered for around three decades in the Faculty of Geography, Gadjah Mada University, Yogyakarta, Indonesia. A long process has been passed until the output reaches 195 (S1), 84 (S2), 3 (S3) alumni in remote sensing and 2 (S3) alumni in geomorphology using remote sensing. Besides, 889 trainees have participated in remote sensing courses. They consist of 779 domestic and 92 expratriate trainees.*

*This article briefly discusses the progress of remote sensing alumni in the Faculty of Geography as viewed from the type of remote sensing systems which are studied, the method of interpretation used, and the fields of it's application. Internal as well as external factor does affect this progress. The internal factor comprises the availability of teaching staff members and laboratory, while the external factor is mainly determined by the growing demand of the output.*

## INTRODUCTION

Faculty of Geography in Gadjah Mada University is the only Faculty of this type in Indonesia. Geography education is offered at the Department of Geography in the Faculty of Mathematic and Science in Jakarta (University of Indonesia), and in numerous Teacher Colleges which are distributed almost in all 27 provinces of Indonesia.

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Based on the fact that : (1) remote sensing images can be acquired very quickly for large areas including those with difficult access (mountain, swamp, forest), (2) it depicts various features, each of which is located as it appears in the field, (3) the repetitive coverage for every area is very high (0.5 hour, 6 hours, 16 days, 26 days, etc.) and (4) it is the only way to record disaster area just when the disaster occurs, remote sensing is recognized as a very useful tool in geography. It is very useful in data acquisition, as permanent and objective record in spatial and temporal analysis. Therefore, the subject of remote sensing has been offered in the Faculty of Geography since the early sixties.

The weight of remote sensing subjects in the completion of a four year program in the Faculty of Geography changes due to the changing curriculum. In the latest development, out of the minimum 144 credits to complete the study, every geography student should have at least 5 credits on remote sensing subjects. At least 20 credits on remote sensing are compulsory for those majoring in remote sensing, which were 33 credits in the former curriculum (Sutanto, 1986).

## DEGREE PROGRAMMES IN THE HIGHER EDUCATION

The existing regulations for higher education in Indonesia state that education can be either academic or professional in character. The academic education is aimed at creating expertise while the professional one is intended to create skills for the alumni.

The academic education in the university is offered in three strata i.e.; the first stratum (S1), the second stratum (S2 or magister level), and the third stratum (S3 or doctorate level). The duration of the S1 ranges from 4 to 5 years with 144-160 credits. The duration of S2 is 2 years with 36-50 credits, and that of S3 is 3 years with 40-50 credits.

The Faculty of Geography has offered a degree programme of S1 level majoring in remote sensing since 1976. The magister program in remote sensing has been offered by the Post-graduate Programme of Gadjah Mada University since the academic year of 1983/1984. Practically, however, it is the Faculty of Geography which manages the programme and the Post-graduate Programme is responsible for financing.

## DISTRIBUTION OF ALUMNI

### S1 Level

The distribution of geography alumni majoring in remote sensing is presented here temporally with 5 year interval. The distribution in each interval is broken down further based on the platform, the type of remote sensing data used in completing the

programme, the methods of interpretation, and the subjects of remote sensing application.

## Platform

Regarding the platform used in recording the surface of the earth, remote sensing progresses from airborne system to spaceborne one. This progress is also reflected in the amount of alumni in the faculty who studied these systems, as presented in table 1.

**Table 1. Temporal distribution of alumni studying airborne and spaceborne systems, 1981-1997**

| System based on platform | Temporal distribution of alumni | | | | |
|---|---|---|---|---|---|
| | 1981-1985 | 1986-1990 | 1991-1995 | 1996-1997 | total |
| Airbone | 28 | 39 | 39 | 26 | 132 |
| Spaceborne | 10 | 16 | 27 | 10 | 63 |
| Total | 38 | 55 | 66 | 36 | 195 |

Source : Anonymous, 1997

Two important points can be drawn from table 1, i.e.; first, the amount of geography alumni majoring in remote sensing tends to increase; and second, similar case does occur for alumni studying spaceborne remote sensing.

Students have dynamic thinking in selecting the major of their study. Economic geography was the first most attractive major in the sixties, followed by hydrology and later by population geography in the seventies. Interest in remote sensing started in the seventies and increased markedly in the eighties. Market demand in the major seems to play a great role in this choice. Besides, the availability of sufficient teaching staff members and reasonably equipped laboratory play their roles as well. Thanks to NUFFIC (Netherlands University Foundation for International Cooperation) for the provision of ralatively strong laboratory of physical geography and cartography, both of which supported greatly the development of remote sensing education in the faculty. More importantly, thank to the national Coordination Agency for Surveys and Mapping (Bakosurtanal) for the establishment of PUSPICS (National Centre for Remote Sensing Education/Training in Indonesia), which was founded in 1977 in the framework of a cooperation between Gadjah Mada University and Bakosurtanal. PUSPICS in the Faculty of Geography helps a great deal in developing remote sensing education and training in this faculty. Gratitude is also addressed to the Ford Foundation and the International Institute for Aerospace survey and Earth Science (ITC) in the Netherlands which helped to strengthen PUSPICS for a five year period each, the latter of which is shortened to a four year period for certain reasons.

Concerning the second point, indeed the alumni studying the spaceborne system of remote sensing started late, but it is notably increasing. The small figure in the period of 1996-1997 is for a short period of only one year, as compared to the former five year period. The late start spaceborne system stems from the fact that the availability of spaceborne data dated from 1976 in this faculty.

## Type of Data Used

Objects on the earth surface can be recorded photographically as well as nonphotographically. The progress of studying these recorded data by the alumni in the completion of their study is presented in table 2.

**Table 2. Type of remote sensing data used by the alumni in the completion of their study, 1981-1997**

| Type of remote sensing data | Temporal distribution of alumni | | | | |
|---|---|---|---|---|---|
| | 1981-1985 | 1986-1990 | 1991-1995 | 1996-1997 | Total |
| Aerial photograph | 30 | 39 | 39 | 26 | 134 |
| Nonphotographic image | | | | | |
| NOAA | - | - | - | 1 | 1 |
| SIR-A & SIR-B | 1 | 2 | 3 | 1 | 7 |
| Landsat (MSS + TM) | 7 | 9 | 6 | 7 | 29 |
| SPOT | - | 5 | 18 | 1 | 24 |
| Total | 38 | 55 | 66 | 36 | 195 |

Source : Anonymous, 1997

Viewed as a whole, most alumni (69%) completed the programme by aerial photograph. At least three reasons underlie this fact, i.e; (1) the availability of aerial photographs in big numbers, (2) the earlier development of the laboratory, and (3) the students had been more accustomed to the aerial photographs. However, this does not indicate a significant increase although the amount of student majoring in remote sensing is increasing.

Regarding the use of nonphotographic data, Landsat ranks the first and it is followed by SPOT data, both of which differ very significantly with SIR-A & SIR-B and NOAA data in term of their amount. Landsat and SPOT data are of greater availability in the faculty so that these data absorb greater concern from the alumni. Besides, these data are not as difficult as radar data to interpret, and not as coarse as NOAA data as far as the spatial resolution is concerned.

One thing is worth to note concerning the use of SPOT data as seen in table 2. Five alumni studied it in the completion of their programmes at the first year of it's availability. It is quite likely due to the much finer resolution as compared with the other nonphotographic images.

## Method of Image Analysis

Remote sensing data can be analised manually with pictorial data or digitally with numerical data. The temporal distribution of these data used by the alumni is presented in table 3.

**Table 3. Temporal distribution of alumni studying remote sensing with manual and digital analysis, 1980-1997**

| Method of analysing remote sensing data | Temporal distribution of alumni | | | | |
|---|---|---|---|---|---|
| | 1981-1985 | 1986-1990 | 1991-1995 | 1996-1997 | Total |
| Manual | 37 | 46 | 33 | 11 | 127 |
| Digital | 1 | 9 | 33 | 25 | 58 |
| Total | 38 | 45 | 66 | 36 | 195 |

Source : Anonymous, 1997

As stated earlier, the increasing major stems from the developing availability of teaching staff and the laboratory. It holds true for the increasing major in the digital analysis.

There are 12 teaching staff members being responsible to offer remote sensing subjects in this faculty. They consist of 1 professor, 1 associate professor, 1 senior lecturers, 3 lecturers, 2 junior lecturers, and 3 assistants. Their academic achievement and their capability of doing digital analysis are presented in table 4.

**Table 4. Academic achievement and analysis capability of the teaching staff members in remote sensing, 1981-1997**

| Time period | Academic achievement | | | Analysis capability | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | S3 | S2 | S1 | S3 | | S2 | | S1 | |
| | (Dr/Ph.D.) | (M.S./M.Sc.) | | M | D | M | D | M | D |
| ≤ 1980 | - | - | 1 | 1 | - | - | - | 1 | - |
| 1981 - 1985 | 1 | - | - | - | - | - | - | - | - |
| 1986 - 1990 | 2 | 3 | - | 2 | 1 | 3 | 1 | - | - |
| 1991 - 1995 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1996 - 1998 | - | - | 2 | - | - | - | - | 2 | 2 |
| Total | 4 | 4 | 4 | 4 | 2 | 4 | 2 | 4 | 3 |

Table 4 informs us that out of the 12 teaching staff members, they consist of 4 Ph.D. holders, 4 M.Sc/M.S. holders, and 4 S1 level holders. All of them are capable of teaching manual analysis of remote sensing, and 7 of them are capable of teaching manual as well digital analysis. The latter consists of 2, 2, and 3 Ph.D holders, M.Sc./M.S. holders, and S1 level holders respectively. Besides, there are 8 ITC alumni of M.Sc. level and 5 other alumni of M.Sc. and Ph.D. levels who support greatly the

remote sensing education and development in this faculty. The digital analysis started some where around 1980 and it is gradually increasing and hence, the start of the major in digital analysis. One graduate had his major in digital analysis in 1981 and he is the pioneer in digital analysis of remote sensing in this faculty who is now the head of PUSPICS, the second successor of this first writer. It is due to the availability of LCT-11 Dyptix System and the Ford Foundation expert at PUSPICS, the former of which was in the period of 1980-1983. The LCT-11 Image Analysis System (Dipix Systems Limited) and the experts were both the aid from the Ford Foundation.

In line with the progress in the staff availability, the laboratory is also making a notable progress. Table 5 may clarify this statement.

**Table 5. Laboratory equipments for remote sensing in the Faculty of Geography, 1998**

| INSTRUMENT/EQUIPMENT | AMOUNT (UNIT) |
|---|---|
| **Interpretation** | |
| 1. Mirror stereoscope, Topcon/Sokhisa | 55 |
| 2. Pocket stereoscope, Topcon | 20 |
| 3. Twin stereoscope | 30 |
| 4. Magnifying loupe | 4 |
| 5. Light table | 1 |
| **Transfer of detail** | |
| 1. Zoom transferscope | 1 |
| 2. Aero sketchmaster | 1 |
| 3. Stereoplotter | 1 |
| 4. Map O graph | 1 |
| **Field surveying/mapping** | |
| 1. Global Positioning System (GPS) | 4 |
| 2. Theodolith | 5 |
| 3. Waterpass | 2 |
| 4. Surveying compass | 3 |
| **Digital Laboratory** | |
| Hardware | |
| 1. Computer, PC/AT 80486 and Pentium 100, 8MB/520MB | 30 |
| 2. Digitizer, A1/A3 | 1/14 |
| 3. Printer, Ao, A1, A4, dot matrix, color printer (A3) | 9 |
| 4. Scanner (A to D converter) | 1 |
| 5. Photo and map reproduction | |
| a. Photographic camera, 40 cm x 60 cm | 2 |
| b. BW photo printer | 1 |
| c. Map printer (flatbed offset) | 1 |
| d. Photo and map contact printer | 1 |
| Software | |
| 1. ILWIS program | 10 |
| 2. ARC/INFO program | 15 |
| 3. Autocard program | 10 |
| 4. ERDAS program | 1 |

## Subject in the Major

Research and report writing are compulsory for every student in completing his/her study. The final report is termed scription, thesis, and dissertation for S1, S2, and S3 program respectively. The distribution of alumni based on the subject of the research is provided in table 6.

**Table 6. Temporal distribution of alumni based on the subject in their major, 1981-1987**

| SUBJECT | TEMPORAL DISTRIBUTION OF ALUMNI | | | | |
|---|---|---|---|---|---|
| | 1981-85 | 1986-90 | 1991-95 | 1996-98 | Total |
| 1. Mapping (cadastral + topographic) | 2 | 2 | 5 | 2 | 11 |
| 2. Landuse/rural survey | 8 | 8 | 5 | 3 | 24 |
| 3. Forestry (resources, conservation | 3 | 1 | 8 | 5 | 17 |
| 4. Soil survey, mapping, erosion | 3 | 11 | 9 | 5 | 28 |
| 5. Urban analysis | 6 | 9 | 15 | 9 | 39 |
| 6. Geomorphology & land resources | 5 | 4 | 2 | - | 11 |
| 7. Geology & mineral exploration | 1 | 1 | 5 | 2 | 9 |
| 8. Hydrology/water resources | - | 6 | 1 | 3 | 10 |
| 9. Marine & coastal study | 1 | 2 | 2 | - | 4 |
| 10. Tourism/cultural resources | - | 1 | 1 | - | 2 |
| 11. Agricultural resources | 1 | 2 | 2 | 1 | 6 |
| 12. Engineering/infrastructure | 1 | - | - | - | 1 |
| 13. Environmental study | 3 | 1 | 2 | 3 | 9 |
| 14. Hazards | 2 | 2 | 2 | - | 6 |
| 15. Land tax | - | 1 | 1 | - | 2 |
| 16. Population estimate | 2 | 1 | - | - | 3 |
| 17. Vegetation monitoring | - | 3 | 6 | 3 | 12 |

Source : Anonymous, 1997

Basing on table 6, urban analysis ranks the first and it is followed by soil survey, land use/rural survey, forestry, and mapping as well as geomorphology and land resources for the big five of the majors. Choice of the major is probably related to the alumni's interest and ability, availability of teaching staff member and laboratory, market demand, and message from the institution sending the student to this faculty. The latest is true for personnel which are sent by particular institution to study for quality improvement of human resources. The sending institutions are the National Agency for Land Affair (BPN), the National Coordination Agency for Survey and Mapping (Bakosurtanal), the Air Force, and the Topographic Service of the Army.

## Magister (S2) Level

Under the auspices of the Post-graduate Program of the University, Faculty of Geography offers four study programmes of S2 level. These programmes are S2 programmes of Geography, Population Geography, Environmental Study, and Remote

Sensing, the latest of which started in the academic year of 1983/1984. The temporal distribution of S2 level in remote sensing is presented in table 7.

**Table 7. Distribution of remote sensing alumni of S2 level based on remote sensing system written in their thesis, 1986-1997**

| Remote Sensing System | Amount of alumni |
|---|---|
| **Platform** | |
| Airborne | 57 |
| Spaceborne | 27 |
| **Type of data** | |
| Aerial photograph | 57 |
| NOOA image | 2 |
| Sir-A & B | 1 |
| Landsat MSS & TM | 6 |
| SPOT | 18 |
| **Analysis** | |
| Manual | 62 |
| Digital | 22 |
| **Field of application** | |
| Cadastral and topographic mapping | 3 |
| Landuse/rural survey | 10 |
| Forestry | 7 |
| Soil survey and mapping | 8 |
| Urban study | 5 |
| Geomorphology and land resources | 13 |
| Geology and mineral exploration | 6 |
| Hydrology | 4 |
| Marine and coastal study | 6 |
| Tourism/cultural resources management | 3 |
| Agriculture | 5 |
| Enginering and infrastructures | 2 |
| Environmental quality/monitoring | 2 |
| Disaster | 2 |
| Land tax | 1 |
| Population estimate | 2 |
| Vegetation monitoring | 4 |
| Others | 1 |

Table 7 indicates that 68% of the 84 alumni of S2 level wrote their thesis based on airborne system of remote sensing and 74% of them worked with manual analysis. Basing on the field of remote sensing application, the top five out of the 18 applications are geomorphology and land resources (13), land use/rural survey (10), soil survey and mapping (8), Forestry (7), geology and mineral application as well as marine and coastal study (5 each). The reasons underlying this fact are similar with that of the S1 level.

### Doctorate (S3) Level

Faculty of Geography also offers S3 programme on behalf of the Post-graduate Program of the University. This programme is offered in two types, i.e: doctorate programme by research and by coursework as well. Dissertation based on intensive research is compulsory to complete the programme for both types. The only difference is that coursework programme is assigned for the later type.
Dissertation may be written in one of the following subjects, i.e.:

1. Geomorphology and land resources, hydrology and water resources, soil geography
2. Remote sensing, cartography, geographic information system
3. Social geography, demography and population geography, geography of settlement, geography of resources
4. Environmental study
5. Regional study

Regarding the S3 programme in remote sensing, three alumni have completed the programme since 1982 and four more are still working on it. Two out of the three alumni are teaching staff members of the faculty, and two out of the four S3 students are also teaching staff members of the faculty.

## COURSES AT PUSPICS

Functioning as the national center for remote sensing education/training in Indonesia, PUSPICS at the Faculty of Geography has offered remote sensing courses of various types and duration since 1976. It covers courses of regular type of 6 month and non-regular type ranging from 5 weeks to 6 months. Starting from 1984, foreign trainees have participated in these courses in this course in the framework of Technical Cooperation between the Developing Countries (TCDC) Programme. Since 1989, remote sensing courses have been offered in integration with geographic information system.

Up to early May of 1998, PUSPICS has trained 797 domestic participants and 92 foreign participants, the distribution of wich is presented briefly in this article.

## DISTRIBUTION OF ALUMNI

### Domestic Participant

The distribution of alumni based on the provinces which send the participants is presented in table 8.

**Table 8. Distribution of domestic alumni at PUSPICS according to their provinces, 1976-1998**

| No. | Provinces sending the participant | Number of alumni |
|---|---|---|
| 1. | Special Region of Aceh | 10 |
| 2. | North Sumatera | 13 |
| 3. | West Sumatera | 22 |
| 4. | Jambi | 13 |
| 5. | Bengkulu | 8 |
| 6. | Riau | 10 |
| 7. | South Sumatera | 13 |
| 8. | Lampung | 16 |
| 9. | West Java | 125 |
| 10. | Capital Special Region of Jakarta | 100 |
| 11. | Central Java | 54 |
| 12. | Special Region of Yogyakarta | 88 |
| 13. | East Java | 51 |
| 14. | West Kalimantan | 15 |
| 15. | Central Kalimantan | 23 |
| 16. | South Kalimantan | 18 |
| 17. | East kalimantan | 41 |
| 18. | North Sulawesi | 14 |
| 19. | Central Sulawesi | 17 |
| 20. | South Sulawesi | 35 |
| 21. | Southeast Sulawesi | 12 |
| 22. | Bali | 22 |
| 23. | West Nusatenggara | 17 |
| 24. | East Nusatenggara | 17 |
| 25. | Maluku | 20 |
| 26. | Irian Jaya | 15 |
| 27 | East Timor | 8 |
| | Total | 797 |

Source : PUSPICS note, 1998.

The biggest number of participants was sent by the five provinces in Java island, i.e.; West Java (125), Jakarta capital (100), Yogyakarta (88), Central Java (54) and lastly East Java (51). Closeness to the capital and to PUSPICS is likely to be one of the reasons underlying this fact.

## Foreign Participant

The distribution of foreign alumni is presented in table 9 based on the country of origin.

**Table 9. The distribution of alumni at PUSPICS according to their countries, 1984-1998**

| No. | Country of origin | Number of alumni |
|---|---|---|
| 1. | St. Vincent | 1 |
| 2. | Myanmar | 6 |
| 3. | The Phillippines | 11 |
| 4. | Nigeria | 1 |
| 5. | Ghana | 1 |
| 6. | Thailand | 8 |
| 7. | Liberia | 1 |
| 8. | Iran | 3 |
| 9. | Laos | 3 |
| 10. | Papua New Guinea | 6 |
| 11. | Bhutan | 3 |
| 12. | Malaysia | 6 |
| 13. | Brunei Darussalam | 1 |
| 14. | Afghanistan | 1 |
| 15. | Mongolia | 6 |
| 16. | Nepal | 6 |
| 17. | Srilanka | 7 |
| 18. | Vietnam | 6 |
| 19. | Bangladesh | 7 |
| 20. | Vanuatu | 1 |
| 21. | Fiji | 1 |
| 22. | Cambodia | 3 |
| 23. | Maladives | 3 |
| | Total | 92 |

Up to this moment, PUSPICS has trained 92 overseas participants sent by 23 countries of Asia, Africa, and an island close to Latin America.

## The Participants in General

As viewed from the final reports to complete the courses at PUSPICS, the distributions of alumni based on the the platform, type of data, analysis, and themes, are presented in table 10.

**Table 10. The distribution of final report written by PUSPICS trainess, 1976-1998**

| Differentiating factor | Number of report |
|---|---|
| **Platform** | |
| Airbone | 600 |
| Spaceborne | 30 |
| **Type of data** | |
| Aerial photograph | 600 |
| Satellite image | - |
| NOAA | - |
| SIR (A & B) | - |
| Landsat (MSS & TM) | 28 |
| SPOT | 2 |
| **Type of analysis** | |
| Manual | 490 |
| Digital | 140 |
| **Theme** | |
| Cadastral survey and mapping | 6 |
| Landuse, rural survey | 225 |
| Forest resources | 16 |
| Soil survey, erosion | 47 |
| Urban/sub-urban | 40 |
| Geomorphology | 107 |
| Geology/mineral exploration | 38 |
| Hydrology/water resources | 64 |
| Marine/coastal application | 10 |
| Tourism/cultural application | 5 |
| Agricultural | 14 |
| Engineering | 8 |
| Environmental quality | 16 |
| Ecological hazard | 2 |
| Population estimate | 4 |
| Vegetation monitoring | 20 |
| Military application | 8 |

The reasons underlying the distribution are similar to those that have been stated earlier.

Out of the whole 889 trainees, 630 final reports were written by them. A great difference on the number of trainees and the final report does occur in this respect. It is due to the fact that not every final report was written individually. Many of them were written in group, especially for the short courses.

## CONCLUDING REMARK

The number of remote sensing alumni has increased considerably since the eighties. Internally, it depends largely on the availability of sufficient teaching staff members and laboratories, both of which have developed well since the mid eighties. Externally, the market demand seems to play a great role in this case. The need to carry out resources inventory and evaluation quickly for Indonesia has put remote sensing technology into great concern in this country. Just to mention one example, remote sensing technology has speeded up the provision of 1 : 50,000 topographic map coverage very significanly. This coverage increased from 14% of the whole land territory in 1974 to 20% in 1982, 60% in 1993, and 70% in the mid 1996 (Sutanto et al., 1996).

Regarding courses of remote sensing, PUSPICS has extended the function from national center into a wider one to train regional participants in collaboration with ESCAP, ITC, BAKOSURTANAL, and the Ministry of Foreign Affair of the Republic of Indonesia.

The progress of studying remote sensing moves from airborne to spaceborne system and from analog to digital analysis accordingly, as generally occurs elsewhere.

## EDITOR'S NOTE

As we know, the Indonesian Journal of Geography accomodates only articles which are based on research work. The last article of this edition is indeed not based on research. It is published here especially for the purpose of giving overall sight to the alumni, which may be of any use also for the readers in general.

## REFERENCES

Anonymous, 1996, Buku Panduan Akademik, *Fakultas Geografi UGM*, Yogyakarta.

----------, 1997 Data Alumni, *Fakultas Geografi UGM*, Yogyakarta.

Sutanto, 1986, Remote Sensing Education and Training in the Faculty of Geography, Gadjah Mada University, Indonesia, In: *Remote Sensing Yearbook 1986*; A. Cracknell and L. Hayes (Eds.), Taylor & Francis, London.

Sutanto, Hartono, dan Projo Danudoro, 1996, Pengembangan Ilmu Pengetahuan dan Teknologi Pemetaan Tanah serta Sumberdaya Manusia Pemetaan Tanah, *Makalah utama pada Seminar Nasional Pemetaan Tanah*, 24-25 Juli 1996, Jakarta.